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INHERITANCE AND LINKAGE RELATIONS OF MUTANT CHARACTERS IN THE DEER MOUSE, *PEROMYSCUS MANICULATUS*

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THE purpose of this publication is to present the results of some inheritance and linkage studies of mutant characters in the deer mouse, *Peromyscus maniculatus*. Descriptions are first given of all the known mutant characters of the deer mouse with information concerning their origin, inheritance, and possible homology with similar characters in other rodents.

MUTATIONS

In recent years a rapidly increasing number of gene mutations have been isolated in mice of the genus *Peromyscus*, most of them having appeared in the widely distributed species, *Peromyscus maniculatus*. The number of known mutations in the deer mouse now rivals those known for the house mouse, *Mus musculus*.

1. Agouti allelomorphs, buff (A^b) and gray (A).—Thus far, no non-agouti mutation has appeared in deer mice. Two general agouti color types, buff and gray, occur in all wild mice of this species; gray is by far the more common agouti color. Buff mice, because of wider yellow agouti bands, have more yellow in their pelages than the gray mice have. Both gray and buff mice vary widely in color, probably because of variations in the intensity of the yellow pigment in the agouti bands. Gray mice of some subspecies are very pale gray (e. g., *P. m. blandus*), but those of other subspecies are extremely dark (e. g., *P. m. rubidus*). Likewise, all shades of buff are found. Some buff animals are bright red or yellow, others are pale, and still others are a dull buff hardly distinguishable from gray.

In the subspecies *P. m. blandus*, gray appears as a simple recessive allelomorph of buff (Dice, 1933). It will be shown later that this same relationship of gray and buff occurs in crosses between certain other subspecies of *maniculatus*.

2. Albinism (C, c).—Albino deer mice are similar to albino house mice in showing complete absence of pigment in the eyes, skin, and hair. Albinism in the wood mouse, *Peromyscus leucopus noveboracensis*, was reported by Castle (1912). It later appeared in *P. m. gambelii* where it acts as a

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simple recessive Mendelian character (Sumner, 1917) closely linked with pinkeye (Sumner, 1922; Clark, 1936). Full color is the only albino allelomorph thus far observed in the deer mouse.

3. Pinkeye (*P, p*), formerly called pallid.—In pink-eyed mice the eyes are pink to dark red, and the black pigment of the pelage and ears is greatly diluted, while the yellow pigment is affected little if any. The underfur is a pale ashy hue, but, in external appearance, the mice are yellow to orange in color. The black guard hairs are absent. Pinkeye (pallid) is a simple recessive character which appeared in the F_2 generation of a cross between the subspecies *P. m. rubidus* and *P. m. sonoriensis* (Sumner, 1917). Since pinkeye and albinism are linked and have nearly the same amounts of crossing over in the Norway rat, the house mouse, and the deer mouse, it seems highly probable that these characters are homologous in these three rodents (Clark, 1936).

4. Ivory (*I, i*).—Ivory deer mice, like pink-eyed mice, have pink or red eyes. The hairs of the juvenile coat are pale buff or pale yellow throughout their length. Ivory mice become progressively lighter in color in successive pelages, the adult coat is sooty or yellowish white in color. The original mutant was a young male *P. m. rubidus* caught by Dr. R. R. Huestis in a live trap set near the outskirts of Eugene, Oregon. This mutation is not an albino allelomorph for when crossed with true albinos normally colored young result (Huestis, Clark, unpublished data). Huestis informs me that crosses of ivory with pinkeye give similar results.

5. Yellow (*Y, y*).—Yellow mice are yellow to orange-yellow; apparently this is due to wider agouti bands which contain brighter yellow pigment than occurs in normal gray deer mice. The base of the hairs is intense black, as in normal gray or buff mice. Occasionally bright reddish buff mice can scarcely be distinguished from yellow ones. A careful examination will separate them, however, as buff mice have black guard hairs whereas the yellow animals have no black pigment in the tips of the hairs. Yellow in the deer mouse seems not to be similar to the all-yellow mutations of other rodents. It is a recessive character discovered in the subspecies *P. m. gambelii* by Sumner (1917).

6. Brown or Cinnamon (*B, b*).—Brown is similar and perhaps homologous to the well-known brown coat color mutation in the house mouse. Since all deer mice are agouti, these mice are brown agouti and probably correspond in genetic type to cinnamon house mice. The underfur is brown or chocolate in color, and the dorsal surface color is yellowish brown. The tail stripe, ears, and soles of the feet are also brown. This simple recessive character was discovered by Huestis and Barto (1934) in the subspecies *gambelii,* and apparently traces back to a single heterozygous adult male trapped at Silver Lake, Oregon.

7. Silver agouti (*Sl, sl*).—Silver agouti mice were first observed in the F_3 generation of a cross between the subspecies *gambelii* and *rubidus*

(Huestis and Barto, 1934). The ancestry of all silver deer mice traces back to a female (subspecies *gambelii*) trapped at the same locality as the animal that gave rise to the brown mutation. The origin and appearance of the silver agouti mutation was reported by Huestis and Barto (1934), who proved also that it is a simple Mendelian recessive character. I quote from the above citation:

> The color difference is produced by a reduction in the amount of black pigment deposited in the proximal portions of a variable number of the hairs of the pelage. Pigment may fail to be deposited just proximal to the agouti band leaving the hair white from there to the base, or it may be merely diminished in amount for a certain length of the hair shaft, such portions alternating with others in which pigment deposition is fairly normal in amount. Rather typically pigment diminution or cessation is preceded by what may be interpreted as an abrupt increase in pigmentation in the form of a large irregular lump or lumps. This involves distortion of the lacunae in this region of the hair and often of the hair shaft as well.

To judge from a single skin that Dr. Huestis kindly sent me, silver agouti deer mice are pale buff in external color. The yellow color of the agouti bands and the black pigment in the tips of the hairs are affected little, if any, by this silver dilution factor.

8. Dilute (*D, d*).—A recessive dilution character affecting both the gray and buff agouti color phases has been described by Dice (1933) in the subspecies *P. m. blandus*. Dilute mice are lighter than normals in external appearance because of reduction of black pigment in the tips of the hairs and proximal to the agouti bands. In dilute *blandus* mice, the black in the underfur is usually diluted to an extent comparable to that in the blue dilute house mouse. In crosses of dilute *blandus* with albinism and yellow, I discovered that many of the F_2 dilute animals exhibit an extreme reduction of black pigment in the underfur, comparable to that in the silver agouti mutation described above. In such animals the underfur is often a sooty white in color, and I have observed lumps of pigment just proximal to the agouti bands similar to those found by Huestis in silver agouti mice. Crosses between dilute and silver agouti mice, however, result in normal F_1 young (Barto, unpublished data). The dilute and silver agouti characters, therefore, are genetically different.

9. Hairless (*Hr, hr*).—Hairlessness in the deer mouse is similar, and probably homologous to recessive hairlessness in the house mouse and Norway rat, and for that reason will not be described in detail. The hairless character was found by Sumner (1924) in the subspecies *P. m. gambelii* and was demonstrated to act as a simple recessive character. Its histological similarity to hairlessness in the house mouse and Norway rat was demonstrated by David (1932).

10. Postjuvenile nude (*N, n*).—Postjuvenile nude is a simple recessive character caused by faulty keratinization of the hairs of the postjuvenile coat which causes them to break off at or beneath the surface of the skin (Clark, MS.). It appeared at the Laboratory of Vertebrate Genetics in the

immediate progeny of a single pair of deer mice belonging to a stock of *P. m. osgoodi* Mearns collected by O. J. Murie near Bear Lake, Utah. As its name indicates this mutation affects chiefly the postjuvenile pelage. Nude mice acquire a normal juvenile pelage, but, as they shed this coat, the postjuvenile coat fails to appear. Depilation of hair begins when the mice are between two and three weeks of age and proceeds in a more or less diffuse manner until the animals are completely naked. The mice become nude at twenty-five to thirty-five days of age and remain that way for about two weeks. When these mice are about fifty days of age the adult coat starts to grow; when complete it is almost normal in color and density. The tip of the nose and the tail may or may not remain bare.

11. Grizzled (*G, g*).—Grizzled deer mice have a variable number of white hairs in the pelage, ranging from a few white hairs on the nose to a condition in which the entire body is nearly white. In appearance, grizzled deer mice resemble silver house mice. The character often does not show in mice before one year of age. It was discovered by Sumner (1932: 35) who observed it in at least three independent lines of the subspecies *gambelii*. The description that Sumner gives of its mode of inheritance indicates that it behaves as an imperfect dominant character.

12. White spotting characters (p_1, p_2, and *S*).—Feldman and Dice (1932) reported the existence of a recessive type of spotting in the subspecies *rufinus* and a dominant type (white-face) in *bairdii*. In a subsequent and very thorough analysis of these spotting characters Feldman (1936) demonstrated that there are two recessive genes (p_1 and p_2) in the *rufinus* stock which interact to produce a range of piebald types. He was able to produce black-eyed white deer mice by combining these two recessive spotting genes of *rufinus* with the dominant *bairdii* spotting factor.

Sumner (1932) observed certain spotting characters in various stocks of *Peromyscus*, but made no serious effort to study them. Barto and Huestis (1933) studied the inheritance of head-star spotting in deer mice of the subspecies *gambelii* and *rubidus* and their hybrids and concluded that the inheritance of star involves multiple genes.

Star or head spots have been observed at the Laboratory of Vertebrate Genetics in many stocks of different subspecies of the deer mouse and have been established in inbred lines of the subspecies *blandus, nebrascensis,* and *bairdii*. Observations made in the process of establishing these inbred lines suggest that these various star spottings are recessive. One cross between star mice of two of these subspecies indicates that the spotting is genetically the same in the two races.

13. Waltzing characters (v_1, v_2, etc.).—Waltzing behavior similar to that in the Japanese waltzing mouse was observed and studied by Dice (1935) in three stocks of different subspecies of the deer mouse. These waltzing characters appeared in the subspecies *P. m. artemisiae, bairdii,* and *rufinus*. In each case, waltzing seemed to be a simple recessive character. Margaret

Liebe (1937) has proved conclusively that the waltzing characters of *artemisiae* and *bairdii* are genetically different, and substantiates the conclusion of Dice that the waltzing of *bairdii* is a recessive character.

14. Epilepsy (*E*, *e*).—Epilepsy was first reported in the deer mouse by Sumner (1932: 38) who observed typical epileptic seizures in a female mouse of the subspecies *P. m. gambelii.* Several offspring of this female exhibited the abnormality, but further studies were discontinued because of the sterility of the strain.

Epilepsy appeared in stocks of the subspecies *artemisiae* and *rufinus* at the University of Michigan and in *artemisiae* was shown to act as a simple recessive character (Dice, 1935). Epilepsy and waltzing are associated in *artemisiae.*

Liebe (1937) has continued these studies of epileptic behavior and the inheritance of epilepsy in the deer mouse in the subspecies *artemisiae, osgoodi,* and *rufinus* as well as in related species of *Peromyscus.* She concludes that epilepsy in *artemisiae* is due to a single recessive gene, whereas in *osgoodi* and *rufinus* it may be due to one, two, or more recessive genes. Normal overlapping makes analysis of these characters very difficult. The types of epilepsy occurring in *osgoodi* and *artemisiae* are very similar, and seizures are brought on by subjection to auditory stimuli such as the shaking of keys or the ringing of a bell. Such stimuli, however, have no effect on the *rufinus* epileptics. In these, the seizure is caused by smoke: tobacco smoke or smoke from oily rags, cotton, or incense will bring about a seizure. Dr. Liebe finds that when epilepsy and waltzing occur in the same stock, as in *artemisiae,* the mode of inheritance of the characters is less clear. They do not segregate in a typically independent manner and yet do not appear to be linked. She suggests that the presence of one character has an effect upon the expression of the other character.

15. Inherited tremor (*T*, *t*).—A lethal character in the deer mouse which causes tremor of the limbs and body, retardation of growth, and death before five weeks of age has been reported by Huestis and Barto (1936). The tremor may appear in affected animals as early as two weeks after birth. Some affected individuals shake constantly, but others seem to shake only when disturbed or moving about. The disparity in size between affected and normal sibs increases with age as does the severity of the tremor. Mice afflicted with tremor have normal hearing. Inherited tremor appears to be a simple recessive character.

16. Flexed tail (*F*, *f*).—The origin and inheritance of a flexed-tail mutation in the deer mouse has been described by Huestis and Barto (1936), who have shown that it is not linked with brown coat color. The anomaly arose in the F_3 generation of a cross between mice of the subspecies *gambelii* and *rubidus,* and it was concluded that one of two *gambelii* females trapped at Silver Lake, Oregon, was heterozygous for the character. Flexed tail is a simple recessive character caused by a shortening and distortion of caudal

vertebrae with disalignment and ankylosis of the intervertebral joints. Newly born flexed-tailed deer mice are not anemic as are flexed-tailed house mice, but in other respects the character is similar in mice of the two genera.

INHERITANCE OF BUFF AND GRAY

Dice (1933) has demonstrated that buff and gray coat colors act as simple allelomorphic characters in the subspecies *blandus,* buff being dominant to gray.

In the herein-described experiment, buff agouti deer mice of the subspecies *nebrascensis* were crossed with gray agouti mice belonging to the subspecies *rubidus* and *bairdii.* The F_1 mice were buff except in those crosses where the buff *nebrascensis* parent happened to be heterozygous for gray, in which case both buff and gray animals appeared in the same litter. In each subspecific cross only the buff F_1 mice were mated together to produce an F_2 population. The F_2 animals from the *nebrascensis* × *rubidus* cross consist of 30 buff and 7 gray mice, and the F_2 population from the *nebrascensis* × *bairdii* cross is made up of 140 buff and 40 gray mice. The combination of the results from the two crosses gives a ratio of 170 buff to 47 gray, a deviation of only 7.2 ± 4.30 from the simple 3 : 1 ratio expected if gray is a simple Mendelian recessive character.

LINKAGE TESTS

1. Pinkeye versus albinism.—Evidence for a high degree of linkage between pinkeye (formerly called pallid) and albinism was found by Sumner (1922), but he did not determine the amount of crossing over between the genes that determine these characters. A recent study by the author (Clark, 1936) indicated that pinkeye and albinism are linked with a crossover percentage of approximately 16.0. This study was continued for the purpose of determining whether or not there is less crossing over in F_1 males than in F_1 females.

In the original cross, pink-eyed mice were crossed with albino deer mice, and the resulting F_1 heterozygous animals were mated with the double recessive pinkeye-albino type. For testing crossing over in F_1 males, F_1 males were mated with pinkeye-albino females; in testing the amount of crossing over in F_1 females, F_1 females were crossed with pinkeye-albino males. In either case, if these characters were not linked we should expect four types of young in equal numbers as follows: normal, pinkeye, albino, and pinkeye-albino. Since the albino and pinkeye-albino mice cannot be distinguished from each other except by breeding tests, their respective classes have been combined in Table I, and crossover percentages were calculated by dividing the number in the normal (crossover) class by one-half the total number of young.

Unfortunately very few fertile double recessive pinkeye-albino females were available to cross with F_1 males, which accounts for the small number

TABLE I

LINKAGE TESTS FOR PINKEYE AND ALBINISM (REPULSION)

The Observed Ratios and Crossover Percentages are Given Separately for Crosses Involving F_1 Females and F_1 Males

	Normal	Pinkeye	Albino and Pinkeye-Albino	Crossover Per Cent	Total Number
F_1 ♀♀	35	155	161	19.94 ± 1.44	351
F_1 ♂♂	5	32	39	13.16 ± 2.70	76
			Diff.	6.78 ± 3.06	

of young from this cross. Referring to Table I we find that the per cent of crossing over is 6.78 ± 3.06 per cent higher in F_1 females than in F_1 males. This difference is 2.2 times its probable error, and, although not statistically significant, it suggests that crossing over may be less frequent in male than in female deer mice.

The results in Table I prove conclusively that the genes for pinkeye and albinism are located in the same chromosome.

A brief article was recently published by Dr. Horace W. Feldman (1937), dealing with the segregation of mutant characters in the deer mouse. In this article, Feldman claims that pallid (pinkeye) and albinism are independent characters. Because he has presented his data in an abbreviated form it is impossible to analyze his results. My thesis, that pinkeye and albinism in the deer mouse are linked characters, is supported by the work of Sumner (1922). I am convinced that Dr. Feldman's conclusions regarding the relations of pinkeye and albinism are erroneous.

2. Hairless versus albinism.—Sumner (1932: 33) states that he reared both albino and colored hairless *Peromyscus* and detected no linkage between these characters. Feldman (1937) found no linkage between albinism and hairless, nor between pallid and hairless.

In the present test, deer mice homozygous for both hairless and albino were crossed with normal mice, and the resulting F_1 young were backcrossed to the double recessive type. If no linkage occurs between these characters, normal, hairless, albino, and hairless-albino young would be expected in equal numbers. The results of this cross are shown in Table II.

Although the observed numbers do not fit the expected ones very closely in the albino and hairless-albino classes, there is no evidence that hairlessness is linked with albinism. In fact, there is an appreciable excess of mice in the crossover albino class while there is a deficiency in the parental hairless-albino class, just the opposite of what we should expect if these characters were linked. Deer mice that are genetically hairless often retain or regenerate most of their coat, but it is generally faded in appearance. Albino hairless mice that retain their hair cannot be detected, however, for they do

TABLE II

BACKCROSS FOR HAIRLESSNESS AND ALBINISM (COUPLING)

	Normal	Hairless	Albino	Hairless-Albino	Total Number
Observed	32.00	28.00	41.00	22.00	123
Expected 1: 1: 1: 1	30.75	30.75	30.75	30.75	....
Dev./P.E.	0.39	0.85	3.16	2.70	....

not differ in appearance from normal albino mice. The deficiency of hairless-albinos and excess of normal albinos is probably due to inability to distinguish normal overlaps for hairless when such mice are homozygous for albinism.

3. Yellow versus albinism.—The absence of linkage between yellow and albinism was indicated by the results of Sumner (1922). Feldman (1937) finds no linkage between yellow and pallid. Since pallid (pinkeye) and albinism are linked his test supports Sumner's results. In the present study the relationship between yellow and albino was investigated by means of the backcross method (Table III). If no linkage occurs between these characters, normal, yellow, albino, and yellow-albino mice would be expected in equal numbers. Since albino and yellow-albino deer mice are phenotypically identical, they were combined in one class. The observed ratio fits the expected 1:1:2 ratio within the limits of normal variation and proves conclusively that the genes for yellow and albinism are located in different chromosomes.

TABLE III

BACKCROSS FOR YELLOW AND ALBINISM (COUPLING)

	Normal	Yellow	Albino and Yellow-Albino	Total Number
Observed	39.00	26.00	60.00	125
Expected 1: 1: 2	31.25	31.25	62.50	....
Dev./P.E.	2.37	1.60	0.66	....

4. Yellow versus dilute.—Yellow and dilute deer mice were crossed and the resulting F_1 animals were mated *inter se* to produce an F_2 population. If yellow and dilute are independent characters, we should expect normal, yellow, dilute, and yellow-dilute mice to appear in the F_2 in the usual dihybrid 9:3:3:1 ratio. The results from this cross are shown in Table IV. As can be seen from this table the observed ratio fits the expected one very

TABLE IV

F_2 FOR YELLOW AND DILUTE (REPULSION)

	Normal	Yellow	Dilute	Yellow-Dilute	Total Number
Observed	84.00	29.00	20.00	9.00	142
Expected 9 : 3 : 3 : 1	79.90	26.60	26.60	8.90	....
Dev./P.E.	1.03	0.76	2.10	0.05	....

closely. There is a slight deficiency of mice in the dilute class, but the deviation is only 2.10 times its probable error. The observed number of mice in the critical crossover yellow-dilute class exactly equals the expected number and proves conclusively that the genes for yellow and dilute reside in different chromosomes.

5. Yellow versus hairless.—Mice homozygous for both yellow and hairless were crossed with normal deer mice, and the normal F_1 animals were backcrossed to the double recessive yellow-hairless type. If no linkage occurs between these characters, normal, yellow, hairless, and yellow-hairless backcross young should appear in equal numbers. Since the faded hair of young hairless gray (hairless-nonyellow) mice might by mistake be classified as yellow, the hairless (nonyellow) and yellow-hairless animals were placed in one group. The results of this backcross are shown in Table V. If these characters are independent in inheritance the numbers of backcross young in the parental normal class and in the yellow crossover class should be approximately equal. The observed numbers of young in these two classes closely fit the expected numbers, and the slight excess of animals in the crossover yellow class eliminates the possibility of linkage between yellow and hairless. These results support the conclusion of Feldman (1937).

TABLE V

BACKCROSS FOR YELLOW AND HAIRLESS (COUPLING)

	Normal	Yellow	Hairless and Yellow-Hairless	Total Number
Observed	21.00	29.00	41.00	91
Expected 1 : 1 : 2	22.75	22.75	45.50	....
Dev./P.E.	0.63	2.24	1.40	....

6. Yellow versus buff.—As pointed out in the description of these characters, yellow and buff are similar characters in that they both affect the extent and color of the yellow pigment in the agouti bands of the hairs

of the pelage. The gene for yellow is recessive and eliminates black pigment in the tips of all the hairs. The gene for buff is dominant and does not eliminate the all-black guard hairs. Yellow deer mice are generally a brighter yellow than buff mice, but the two types may be very similar in appearance.

In this linkage test, bright yellow buff deer mice of the subspecies *nebrascensis* were crossed with yellow mice that were homozygous for gray. The F_1 buff animals were backcrossed to the double-recessive yellow-gray type. Buff, yellow, gray, and yellow-gray backcross young would be expected in equal numbers unless buff and yellow are linked. The classification of these young was difficult since the yellow (nongray) and yellow-gray types are indistinguishable in appearance, and the buff type could easily be confused with the yellow and yellow-gray types. Gray mice, however, are easily distinguishable from animals of the other three types. In this cross, gray is a crossover class, and any deficiency in the number of mice in this class would indicate probable linkage between the genes for yellow and buff. If no linkage occurs between yellow and buff we should expect that one backcross young in every four would be gray in appearance. An examination of Table VI will show that this expectation has been realized, and that yellow and buff are not linked characters.

TABLE VI

BACKCROSS FOR YELLOW AND BUFF (REPULSION)

	Buff, Yellow or Yellow-Gray	Gray (Nonyellow)	Total Number
Observed	119.00	41	160
Expected 3:1	120.00	40	....
Dev./P.E.	0.27	.....	....

7. Buff versus hairless.—Buff deer mice of the subspecies *nebrascensis* were crossed with hairless-gray mice. The F_1 buff animals (heterozygous

TABLE VII

BACKCROSS FOR BUFF AND F_2 FOR HAIRLESS (COUPLING)

	Buff	Gray	Buff-Hairless	Gray-Hairless	Total Number
Observed	41.00	29.00	11.00	7.00	88
Expected 3:3:1:1	33.00	33.00	11.00	11.00	....
Dev./P.E.	2.34	1.17	0.00	1.91	....

for buff and hairless) were crossed with gray animals that were heterozygous for hairless. From this cross, which is a backcross for buff and an F_2 for hairless, we should expect buff, gray, buff-hairless, and gray-hairless mice to appear in a ratio of 3 : 3 : 1 : 1. The results from this cross are tabulated in Table VII.

The observed numbers of young from this cross approximate the expected numbers within the limits of chance variation. If buff and hairless were linked, we should expect a deficiency in the number of mice in the buff-hairless crossover class and an excess of mice in the parental gray-hairless class. Since nothing of this sort occurs, we may conclude that the genes for buff and hairless are located in different chromosomes.

LITERATURE CITED

BARTO, ELIZABETH, AND R. R. HUESTIS

1933 Inheritance of a White Star in the Deer Mouse. Journ. Hered., 24: 245–48.

CASTLE, W. E.

1912 On the Origin of an Albino Race of Deer-mouse. Science, 35: 346–48.

CLARK, F. H.

1936 Linkage of Pink-eye and Albinism in the Deer-mouse. Journ. Hered., 27: 259–60.

DAVID, LORNA T.

1932 The External Expression and Comparative Dermal Histology of Hereditary Hairlessness in Mammals. Zeitschr. f. Zellfarsch. u. mikrosk. Anat., 14: 616–719.

DICE, L. R.

1933 The Inheritance of Dichromatism in the Deer-mouse, *Peromyscus maniculatus blandus.* Amer. Nat., 67: 571–74.

1935 Inheritance of Waltzing and of Epilepsy in Mice of the Genus *Peromyscus.* Journ. Mamm., 16: 25–35.

FELDMAN, H. W.

1936 Piebald Characters of the Deer Mouse. Journ. Hered., 27: 301–4.

1937 Segregation of Mutant Characters of Deer-mice. Amer. Nat., 71: 426–29.

FELDMAN, H. W., AND L. R. DICE

1932 The Genetics of Hairlessness and Color Characters in the Wood Mouse. Proc. Sixth Int. Cong. Genet., 2: 251.

HUESTIS, R. R., AND ELIZABETH BARTO

1934 Brown and Silver Deer Mice. Journ. Hered., 25: 219–23.

1936*a* Flexed-tailed Peromyscus. *Ibid.,* 27: 73–75.

1936*b* An Inherited Tremor in Peromyscus. *Ibid.,* 27: 436–38.

LIEBE, MARGARET

1937 The Inheritance of Epilepsy and of Waltzing in *Peromyscus.* [Thesis, Univ. Mich., 1937.]

SUMNER, F. B.

1917 Several Color Mutations in Mice of the Genus *Peromyscus.* Genetics, 2: 291–300.

1922 Linkage in *Peromyscus.* Amer. Nat., 56: 412–17.

1924 Hairless Mice. Journ. Hered., 15: 475–81.

1932 Genetic, Distributional, and Evolutionary Studies of the Subspecies of Deer Mice (Peromyscus). Biblio. Genet., 9: 1–106.